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DEVICE FOR MEASURING WEIGHT IN A VEHICLE

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Background Information

The present invention is directed to a device for measuring
10 weight in a vehicle according to the definition of the species
in the independent claim.

From DE 199 48 045 Al a device for measuring weight in a
vehicle is known, strain gauges being used and the weight
15 being determined through the elongation of the strain gauge.

Advantages of the Invention

The device according to the present invention for measuring
20 weight in a vehicle, having the features of the independent
claim, has the advantage over the related art that the
elongation and thus the weight is now determined using a
transit time measurement, rather than through a change in
electrical variables, as in the case of a strain gauge, but
25 through transit time differences, which are preferably
determined using ultrasonic pulses. Compact sensors may be
used for the transit time measurement. Furthermore,
measurement of the force distribution is possible. The
analysis system may be of robust design. The device according
30 to the present invention, and in particular the sensor
measuring principle, are capable of self-testing and
economical.

Through the measures and refinements set forth in the
35 subclaims, advantageous improvements on the device for

measuring weight in a vehicle specified in the independent
claim are possible.

Particularly advantageous is the fact that the sensor system
5 for transit time measurement uses mechanical waves.

Mechanical waves are able to propagate in particular on solid
bodies, but also in liquids or gases, and are reflected at
separation layers, and thus make simple determination of the
elongation possible through transit time differences.

10 It is also advantageous that ultrasonic waves in particular
are used as the mechanical waves. Ultrasonic waves allow a
particularly sensitive measurement of small elastic
elongations. Steel bodies may be preferably measured
15 therewith particularly precisely in regard to their
elongation. The pulse echo method is preferably used to that
end. The ultrasonic frequencies are generated for example in a
range around 15 MHz, and are then injected into the expansion
unit. The wave propagates longitudinally and transversely,
20 and is reflected for example by the end surface of the
expansion unit. The transit time difference between
transmitted and received pulses is measured, hence the
designation of pulse echo method. The pulse frequency will be
between 500 Hz and 5000 Hz. The change in transit time
25 difference is the measure of the elongation of the bolt, and
thus of the weight that is being measured.

For ultrasonic measurement, an ultrasonic probe is provided on
the vehicle seat, which may be coupled mechanically with a
30 seat element, so that the gravitational force is transferred
to the ultrasonic probe and causes the elongation of the
ultrasonic probe. This elongation may be the result of
bending or torsion. The ultrasonic probe may preferably be
placed in seat mountings. The seat element may form at least
35 in part the seat surface or the backrest.

Drawing

Exemplary embodiments of the present invention are illustrated in the drawing and are explained in greater detail in the
5 following description.

Figure 1 shows a schematic representation that illustrates the transfer of the sitting force to an elongation of an ultrasonic probe.

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Figure 2 shows a second representation that describes the transfer of the sitting force to torsion of an ultrasonic probe.

15 Figure 3 shows a second representation that shows a top view of the transfer of the sitting force to torsion of an ultrasonic probe, i.e., in the direction of the force impact.

20 Description of the Exemplary Embodiments

To determine seat occupancy in vehicles, sensors are used with the help of which the sitting force on the individual seats is determined. Heretofore, sensors based on strain gauges have
25 been used for this purpose. Seat mat sensors are also known, a change in electrical variables being in all cases changed to an elongation.

According to the present invention, it is now proposed to
30 determine this elongation through transit time differences, preferably measured using ultrasonic pulses. This results in a robust measuring method, which is capable of self-testing, allows simple measurement of the force distribution, and gets by with compact probes.

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This requires a sensor system that is able to measure an elastic elongation sensitively. A preferred possibility for the expansion unit is a component made of steel having an integrated ultrasonic transmitter. A piezoelectric layer, 5 made for example of zinc oxide, aluminum nitride or PZT, is applied to the expansion unit as an elastic body. The deposition is accomplished using physical methods, such as a plasma gaseous phase deposition (PVD = plasma vapor deposition). On top of the piezoelectric layer a metal layer 10 is applied, structured for example using shadow masks or photolithography, which functions as an electrode.

To measure the elongation of the expansion unit, a high frequency in the range of 15 MHz is injected into the 15 piezoelectric layer through the metal contact. A mechanical wave (ultrasound) is thereby injected into the expansion unit. The wave propagates in the expansion unit as a longitudinal and transverse wave, and is reflected for example by the end surface of the expansion unit. The transit time difference 20 between transmitted and received pulses is measured - this is the pulse echo method - a frequency of around 500 Hz to 5000 Hz being used. The change in the transit time difference is a measure of an elongation of the expansion unit, and thus of the weight that has been placed on the seat.

25 Figure 1 shows schematically the transfer of the sitting force to an elongation of an ultrasonic probe. Sitting force F is applied here to the center of a seat element 1. Beneath seat element 1 is an ultrasonic probe 2, which also has for example 30 lateral reflector notches. This ultrasonic probe 2 is coupled with seat element 1 through a mechanical coupling 3. In addition, ultrasonic probe 2 is held firmly in place by a mechanical suspension, i.e., a fixed bearing, having an electrical trigger unit of the ultrasonic probe at its other 35 end. Alternatively, it is possible to also provide an electrical trigger unit in area 5 of ultrasonic probe 2. In

addition, it is possible for ultrasonic probe 2 to be firmly clamped at a plurality of places.

Sitting force F is passed on to ultrasonic probe 2 through mechanically non-positive connection 3. Ultrasonic probe 2 is elongated or compressed by bending. Ultrasonic probe 2 is thus used as an expansion unit. The uniaxial bending in the direction of force F may be evaluated using the pulse echo method, as described above. To that end, ultrasonic pulses are generated by an ultrasonic transmitter and injected into ultrasonic probe 2, which is preferably made of steel. The transit time differences between the coupled and received pulses is measured. Through this transit time difference, the length of the probe is measurable, and thus also its elongation in comparison to the normal length. The transit time measurement is performed at 15 MHz. A pulse repetition frequency of 1 KHz may be used. A range of 500 Hz to 5 KHz is conceivable. It is possible to determine transit time measuring values to a precision of 100 picoseconds.

Electrical trigger unit 5 has a plausibility algorithm which ensures that out of 1000 measured values 500 precise and error-free values are transmitted to the controller.

Figure 2 shows another representation, in which sitting force F is transferred to a torsion of ultrasonic probe 2. To that end there is a different mechanical coupling 13 between seat element 1 and ultrasonic probe 2. In addition, a mechanical guide 14 for the torsion is necessary at the other end of the ultrasonic probe. The mechanical coupling between ultrasonic probe 2 and seat element 1 is embodied here in a sort of crossbar, so that force F results in a rotary motion on ultrasonic probe 2 via mechanical coupling 3; mechanical guide 14 contributes to this motion.

Figure 3 shows in a top view how the system for transferring the sitting force to a torsion of ultrasonic probe 2 is

configured. The top view shows the system in the direction of the force impact. Sitting force F is represented accordingly, the axis of torsion being indicated by L and L'. An axle bearing 6 around ultrasonic probe 2, as well as mechanical coupling 13 and mechanical guide 14 are necessary to convert the force impact into a torsion acting on the ultrasonic probe. A mechanical clamping system 15 having electrical tensioning of ultrasonic probe 2 is also necessary for this torsion probe.

10 In principle there are additional possibilities for converting sitting force F into an elongation of an ultrasonic probe. Through locally applied ultrasonic probes it is possible in principle to measure the distribution of the sitting force
15 over the seat surface and backrest. The possibility also exists, for example, of integrating ultrasonic probe 2 directly into the seat mountings.